TISA Working Group Update

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CERES Science Team Meeting
Lawrence Berkeley National Laboratory, Building 66, Berkeley, CA
October 29-31, 2019

OUTLINE

- FluxbyCloudType (FBCT) Product, **Moguo Sun**
  - The FBCT product description
  - FBCT-monthly and daily products
  - Validation and Beta tester results
  - Public Release
- TISA
  - Ed5 TISA/Flashflux/SARB framework
  - GEO daily gain monitoring

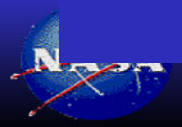
Ed5 flowchart

CERES processing editions

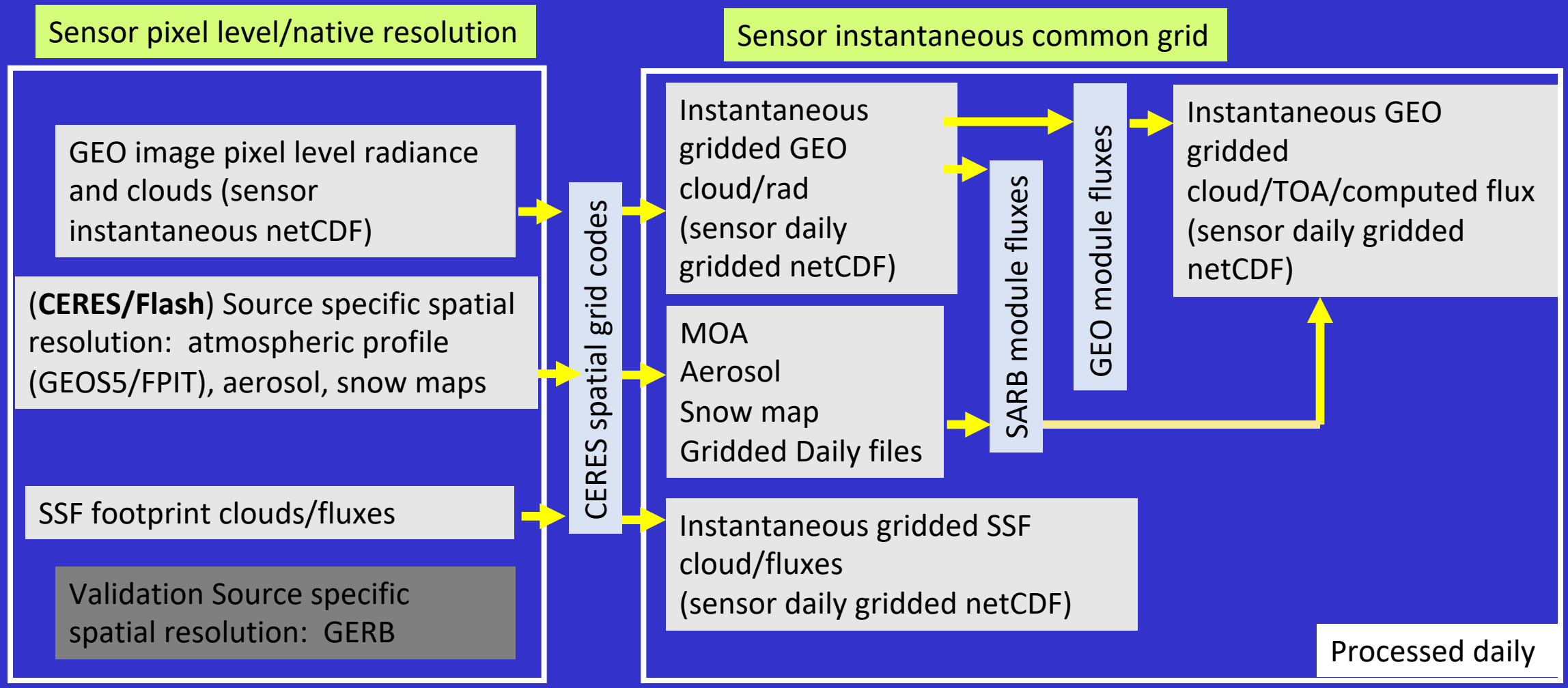
- **Ed2**
  - CERES-only (SSF1deg), CERES+GEO (SYN1deg), and SARB tuned fluxes all in one product package (SRBAVG/ZAVG/AVG)
  - CERES-only fluxes not dependent on GEO or SARB and held up by GEO and SARB
  - SARB-tuned fluxes dependent on GEO broadband fluxes
- **Ed4**
  - SSF1deg product is the CERES-only and release soon after release of SSF
  - SYN1deg product contains both the CERES+GEO and SARB tuned fluxes
- **Ed5**
  - Remove the Tuned SARB fluxes from SYN1deg to allow SARB and TISA to improve in parallel and remove the contingency of TISA for the SARB release
- **Ed5** TISA/SARB/FlashFLUX framework

Ed5 TISA/SARB/FlashFLUX requirements

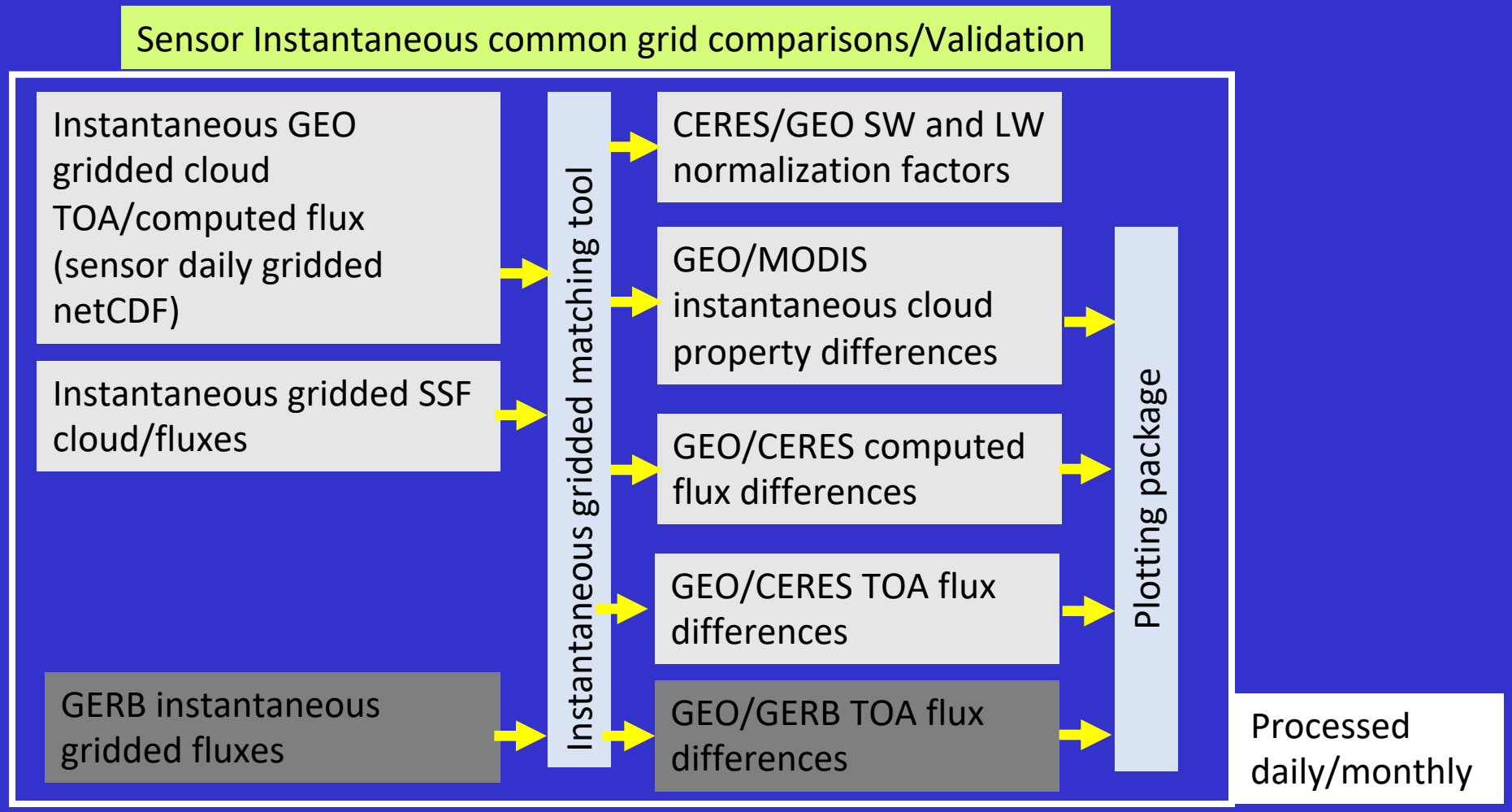
- FlashFLUX
  - requires **local** 3-day (months) processing and run daily
  - Incorporate the GEO Fu-Liou computed fluxes
  - Migrate to same code as CERES, To facilitate new inputs of NPP, NOAA-20, and GEO clouds and fluxes into FlashFLUX processing
- TISA
  - Run GEO NB to BB and computed fluxes at the instantaneous gridded level, allows flexibility to change the cloud/atmosphere/channel radiance parameters, rather than drag parameters through the entire TISA code at the regional processing module
  - Each SW flux will be assigned a directional model, This facilitates nearly the same TISA code to temporally interpolate and to average fluxes for SSF1deg and SYN1deg, lite, and Flashflux.
- SARB
  - Remove tuned fluxes, removes contingency of GEO derived fluxes
  - Computed fluxes to be run daily, rather than by monthly-zonal processing, for efficiency
  - Computed fluxes to be run for single GEOs to facilitate quick validation of surface fluxes.



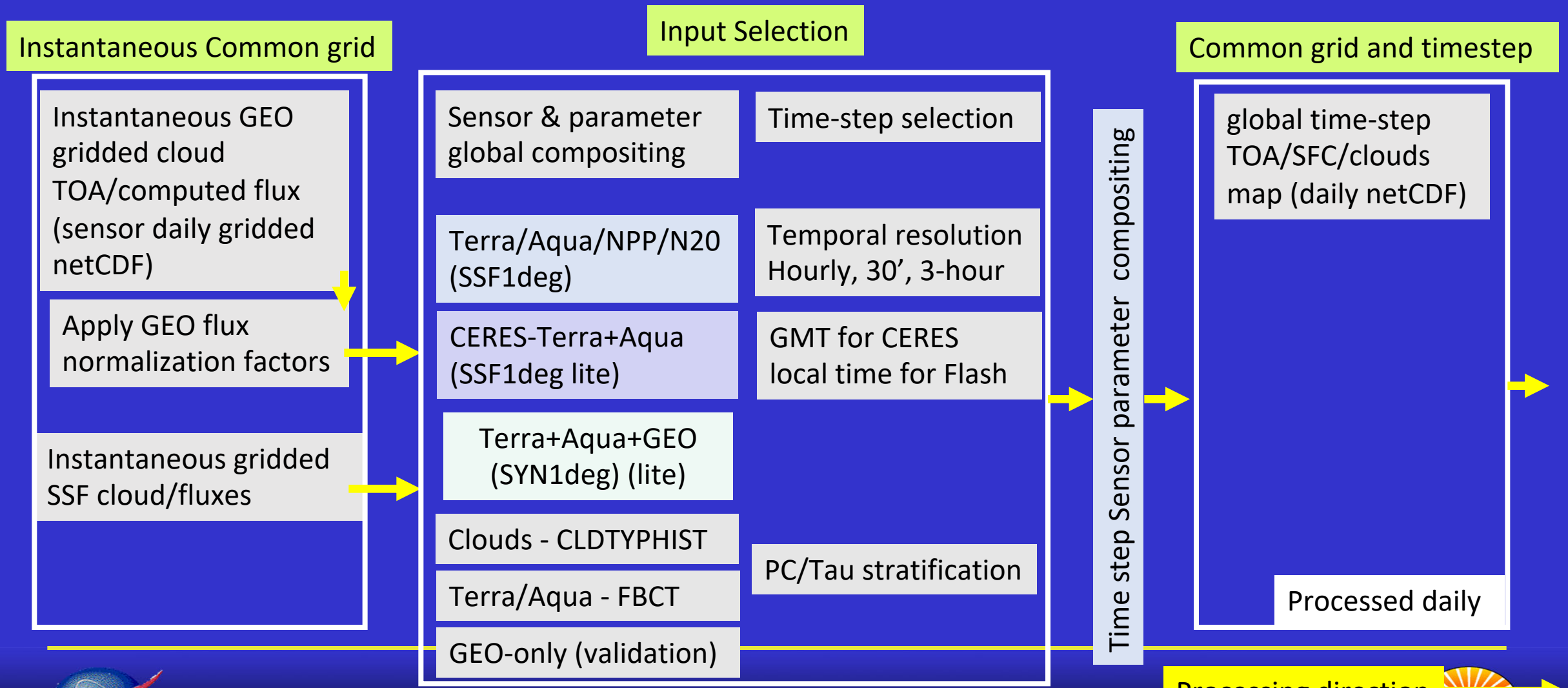
Ed5 flowchart



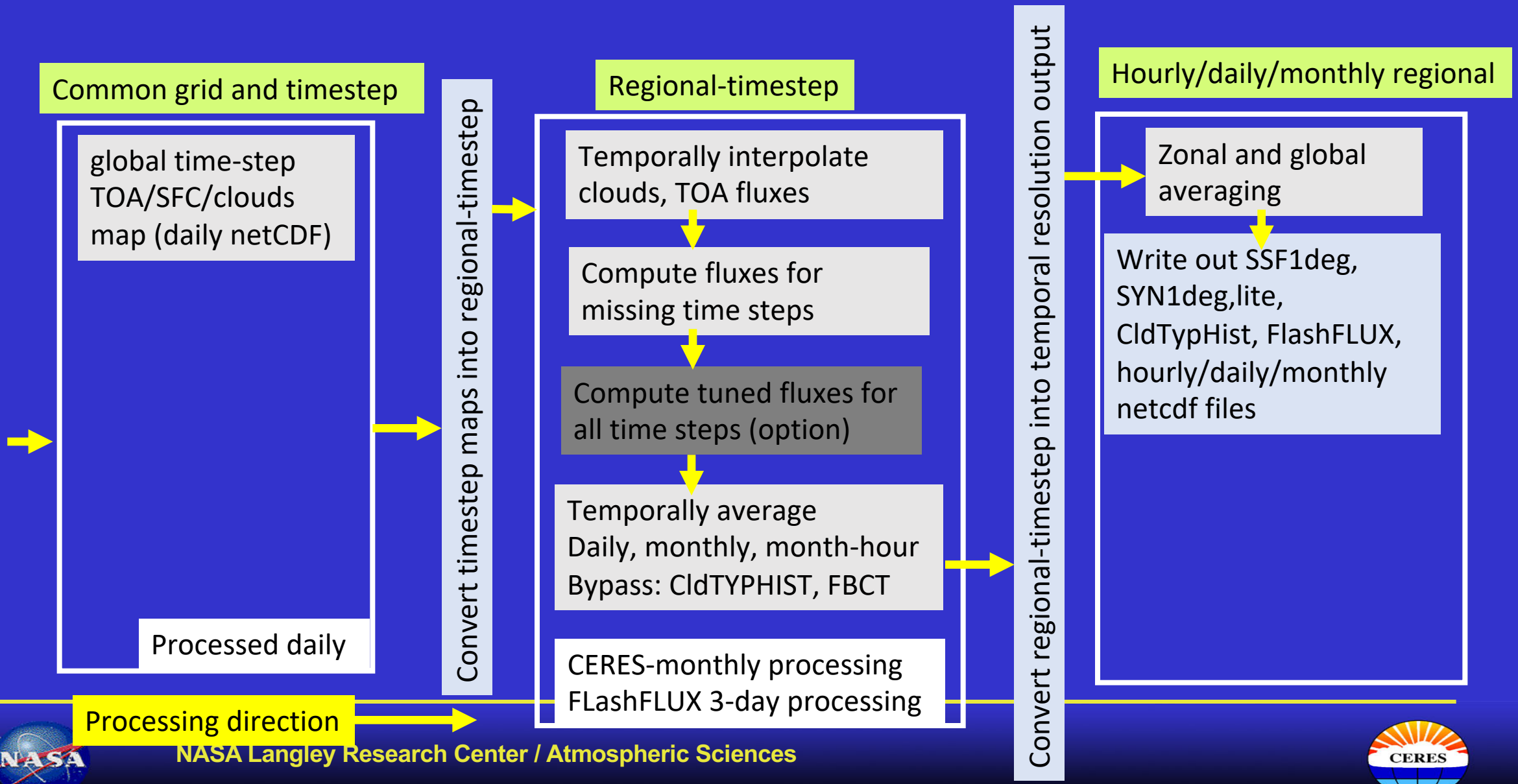
Ed5 flowchart



Ed5 flowchart



Ed5 flowchart



L1B daily monitoring

NOAA GOES-16 ABI Calibration Events Log

- First of all, usually there are no sensor event logs, GEO L1B never reprocessed
- I praise NOAA efforts to provide this web page to the remote sensing community

This is a partial list, only listed the visible calibration issues

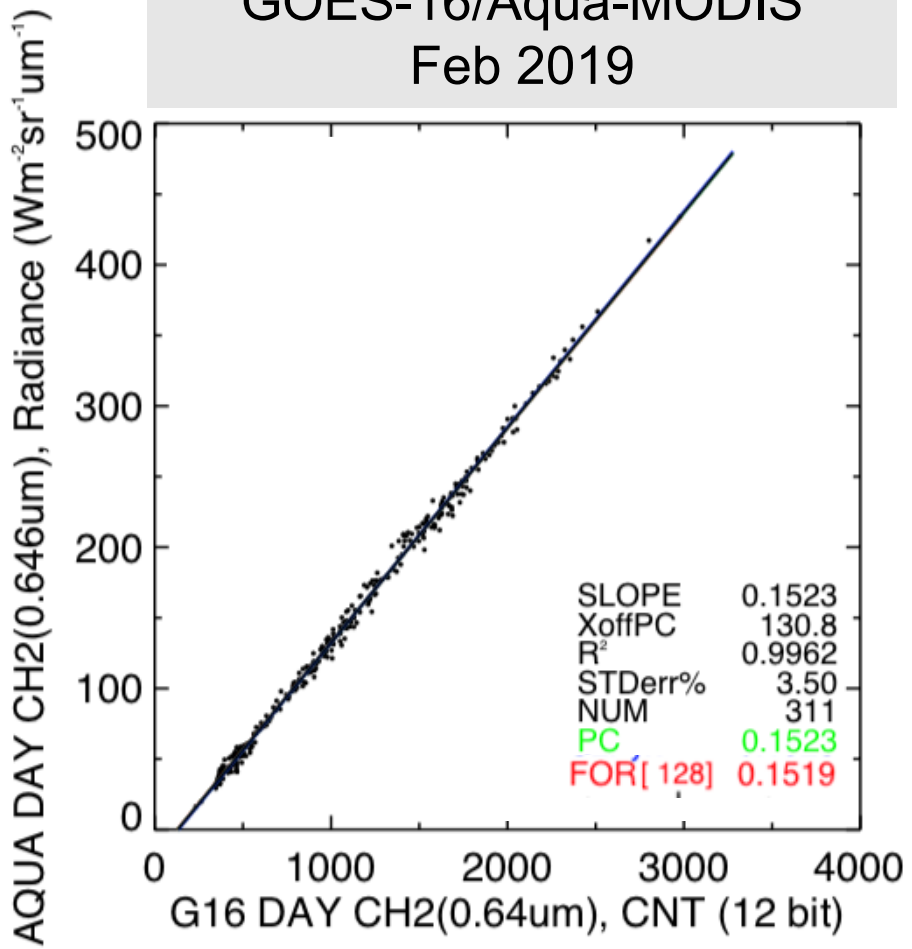
Event	StartDate	EndDate	Notes
B05 10% jump	12/12/2017	12/29/2017	In-correct B05 solar calibration coefficient was used during this period
VNIR Operational Algorithm Update	1/17/2018	2/7/2018	A new calibration algorithm was operationally implemented to reduce the VNIR striping observed since in-orbit. This implementation was accomplished with two steps: the first step was the upload of the new detector non-linearity (Q) LUT for B01/B02/B03 on 01/17/2018 and the second step was to implement the new algorith using Q-scaling on 02/07/2018. This new algorithm resulted in significant reduce in striping at B01/B02/B03 and slight change in the VNIR radiometric calibration accuracy. No change in B05 striping.
Unexpected G16 VNIR gain jumps	04/08/2019	04/09/2019	All the G16 VNIR bands experienced a unexpected large jump (>10%) after the GS software update (DO.07.02) on 04/08/2019. An unknown origin of the gains were used after this GS update. On 04/09/2019 the previous solar cal gain values derived with DO.07 using the 03/26 solar cal. data were re-applied to generate L1B data. Visible striping can be observed in the G16 L1B images during this abnormal period.
G16 B02 bias correction	04/23/2019		1)GOES-16 new B02 K-LUT was implemented on GS at 11:00UTC on 04/23/2019(B02 with CWG's delivery. The other bands corrected with CDRL079_FM1_RevF); 2) calibration algorithm with RevG 3) instrument-to-spacecraft alignment angles with CDRL79-FM1_RevM. The major impact is that G16 B02 radiance is reduced by about ~6.2%.

Magnitude not cited

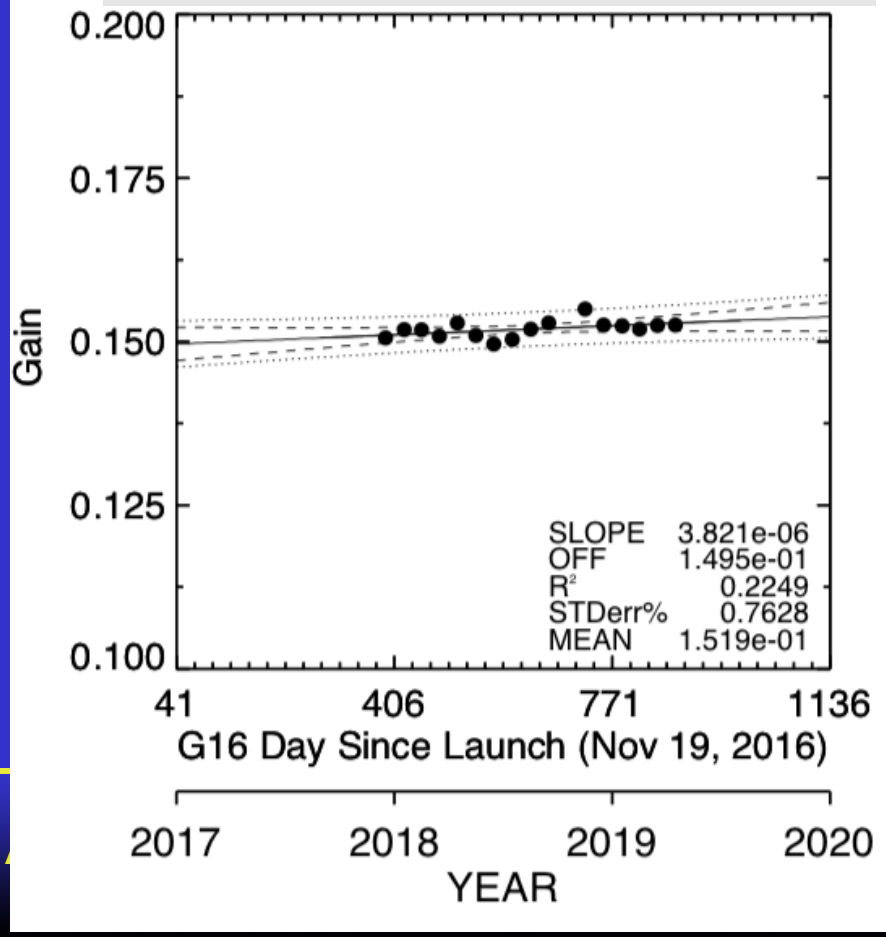
https://www.star.nesdis.noaa.gov/GOESCal/goes_SatelliteAnomalies.php

GEO/MODIS ATO ray-matching calibration algorithm

GOES-16/Aqua-MODIS
Feb 2019

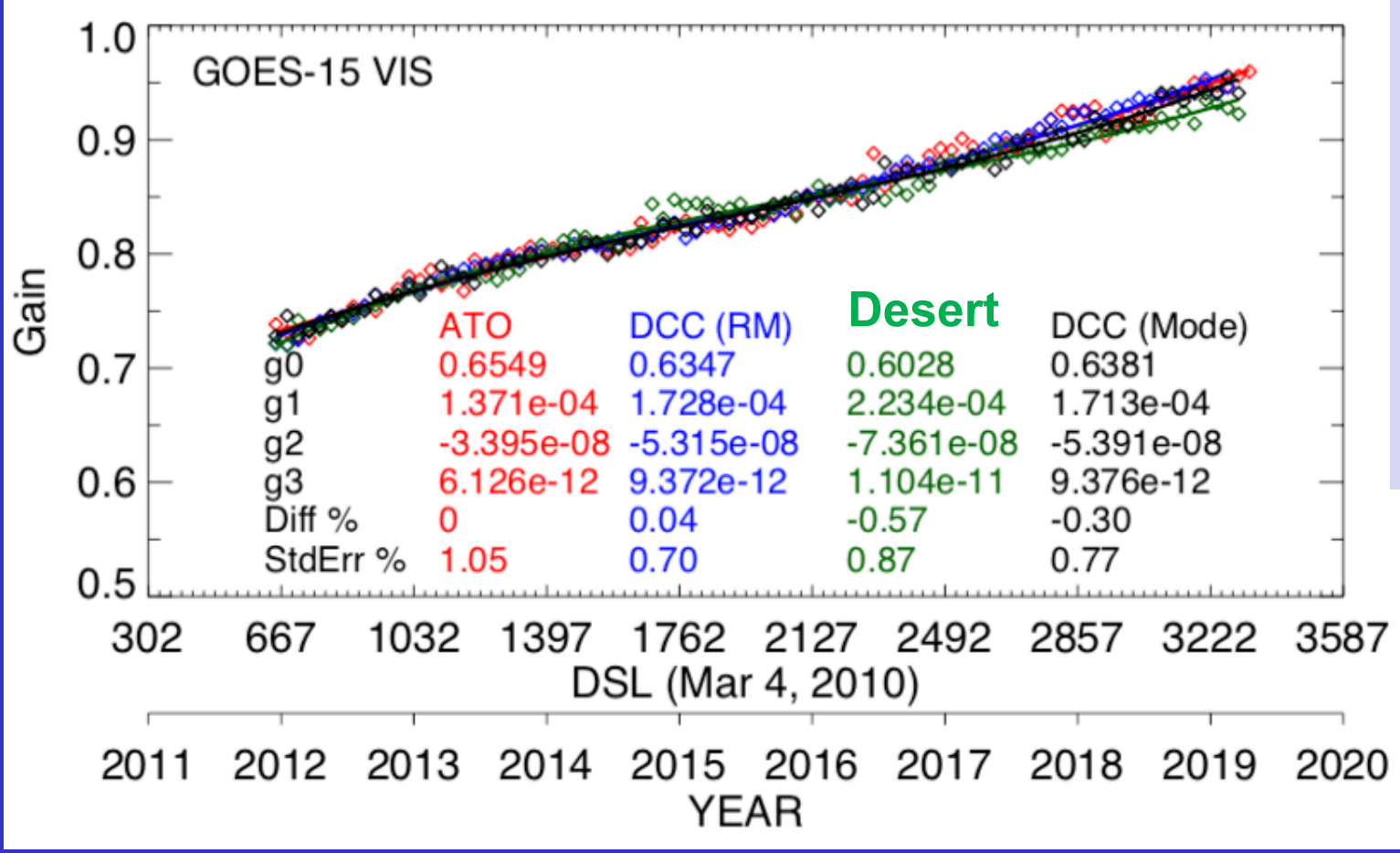


GOES-16 gain referenced to
Aqua-MODIS



- Find within 15 minute coincident GOES-16 and Aqua-MODIS 50-km ray-matched radiances over all-sky ocean
- Apply spectral band adjustment factor
- Linearly regress through the space count the ray-matched radiances to obtain the monthly gain factor
- Linearly regress (2nd order) the monthly gain factors to obtain the calibration coefficients over time.

CERES Ed4 calibration methodology validation



- The ATO-RM is the primary calibration method, the other 3 methods are used to validate the primary method
- All methods independently transfer the Aqua-MODIS calibration standard
- The 4 method mean timeline gains are within 0.6%

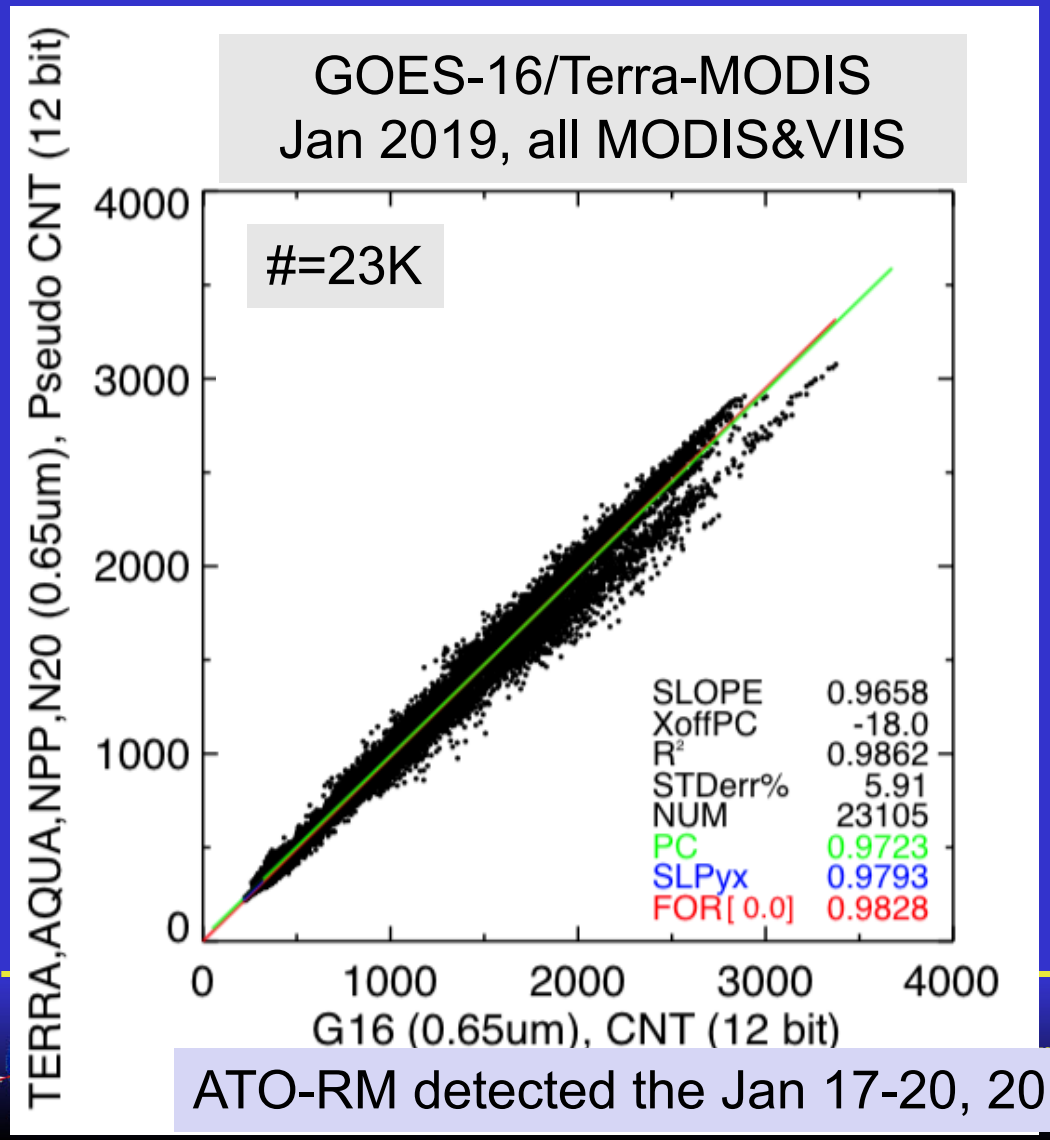
CERES Edition 4 calibration website:
https://satcorps.larc.nasa.gov/cgibin/site/showdoc?mnemonic=CALIB-ED4

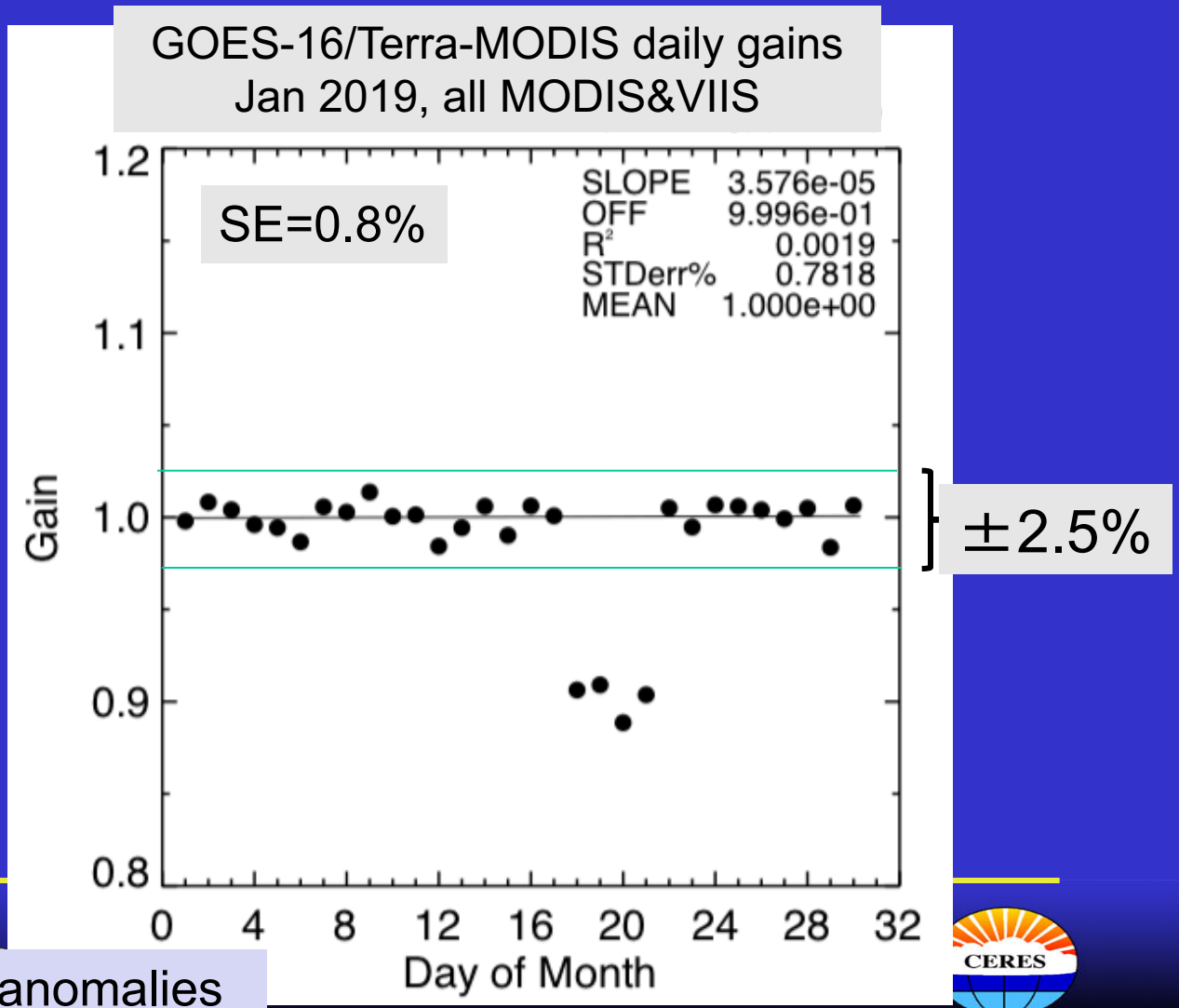
Realtime GEO calibration web site:
https://satcorps.larc.nasa.gov/cgibin/site/showdoc?mnemonic=CALIB-UPRT

Doelling, et al., Geostationary Visible Imager Calibration for the CERES SYN1deg Edition 4 Product. *Remote Sens.* **2018**, *10*, 288.

ATO ray-matching daily monitoring, Jan 2019

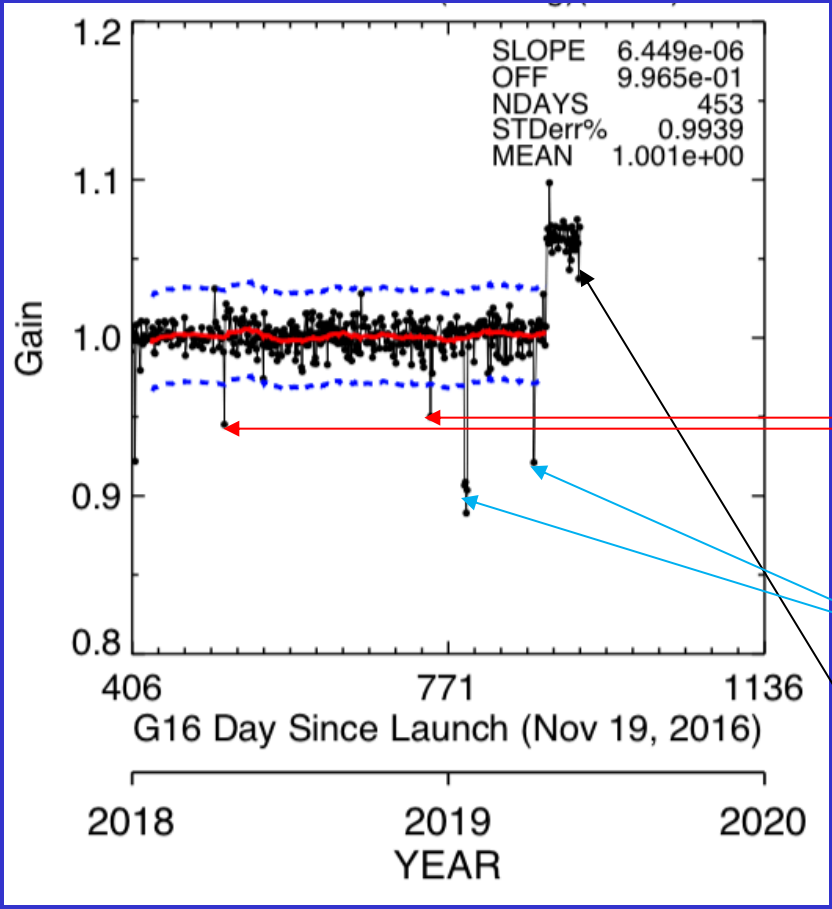
Use Terra, Aqua, NPP and N20 ray-matches to increase sampling





ATO-RM detected the Jan 17-20, 2019 anomalies

GOES-16 daily ATO-RM gain monitoring



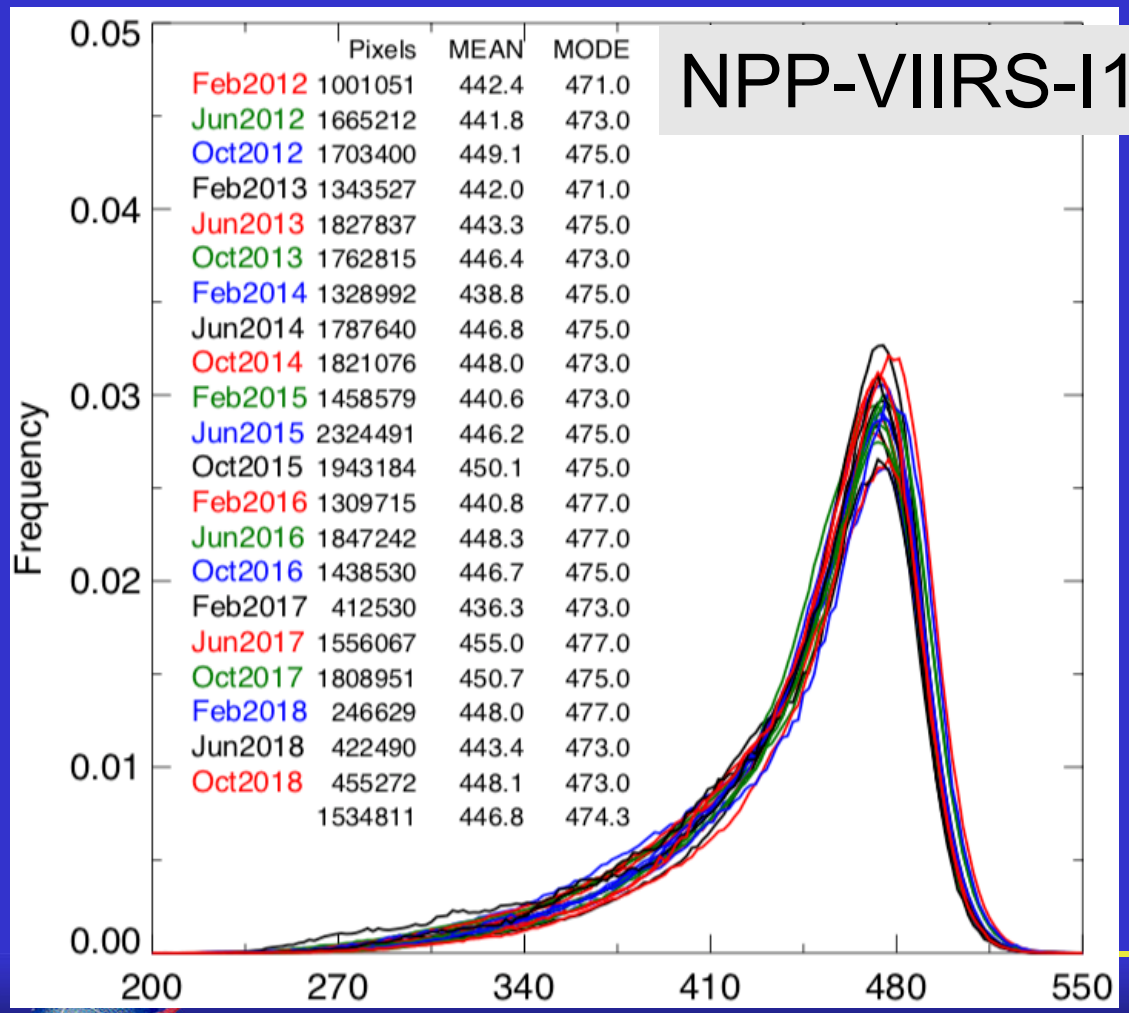
The daily gain standard error is 1.0%, all daily gain departures > 3% are considered L1B anomalies

Only two false positives exceeded ±3%, after filtering 9% of all days

Known L1B anomalies from NOAA GOES-16 web page

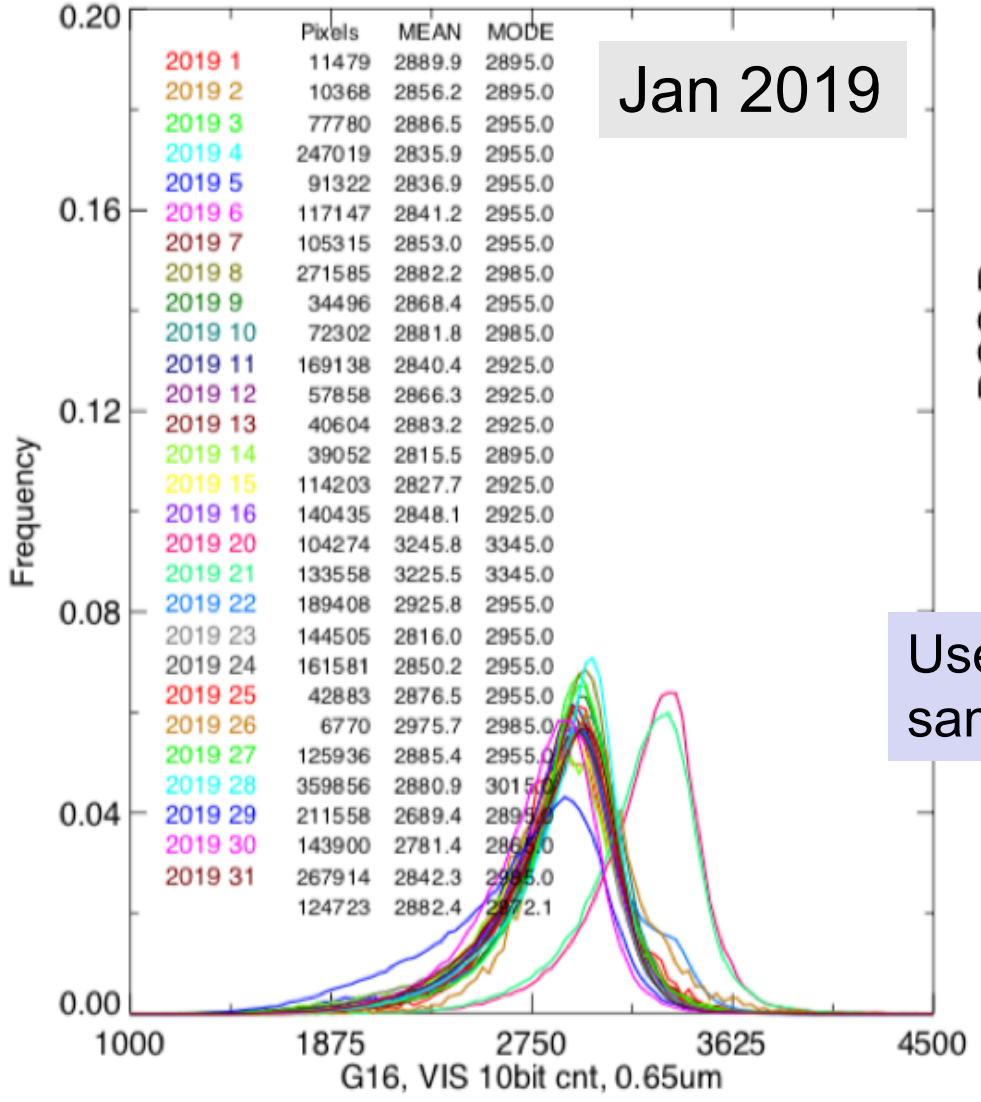
Known ch2 calibration gain 6.2% adjustment from NOAA G16 event log page

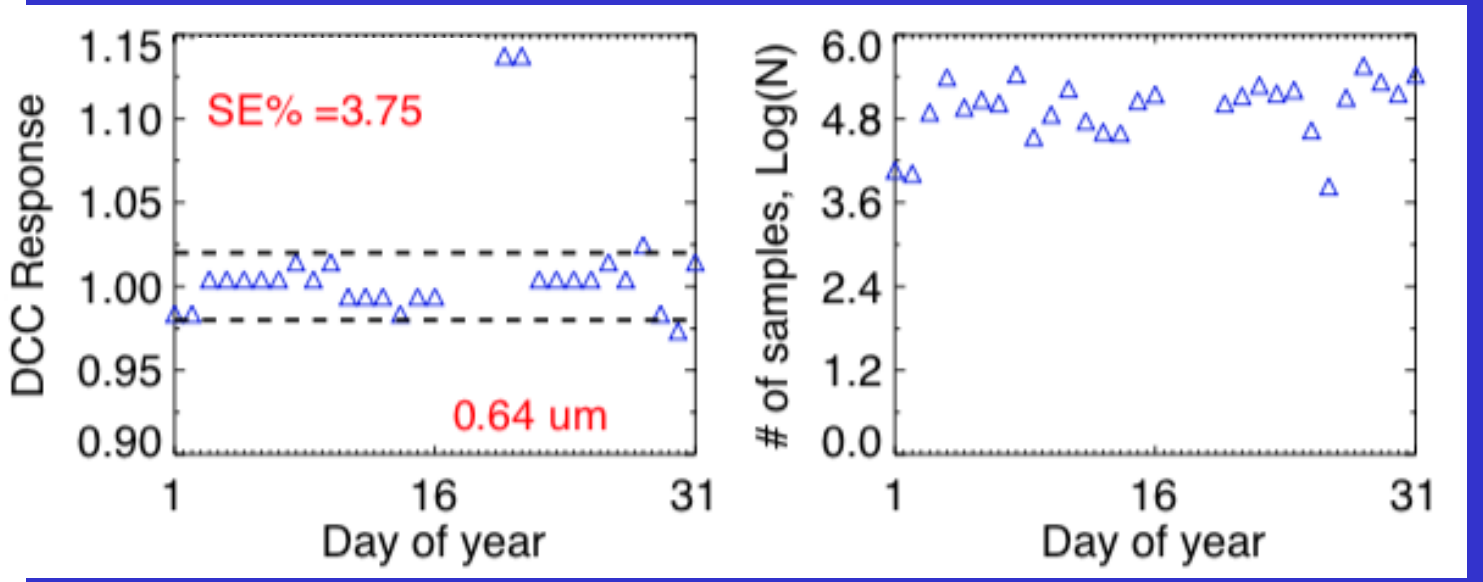
DCC invariant target (IT) calibration algorithm



- DCC is a statistical approach that assumes that the collective tropical DCC reflectance is invariant
- DCC pixels are identified as BT<205K, SZA<40°, VZA<40°, VIS<3% and IR<1K
- Apply DCC BRDF, which in this case is a very small adjustment
- The DCC pixels are compiled into a monthly probability density functions (PDFs) and the PDF mode DCC radiance is tracked over time. For wavelengths<1μm use the mode statistic, >1μm then mean

DCC IT daily monitoring, Jan 2019

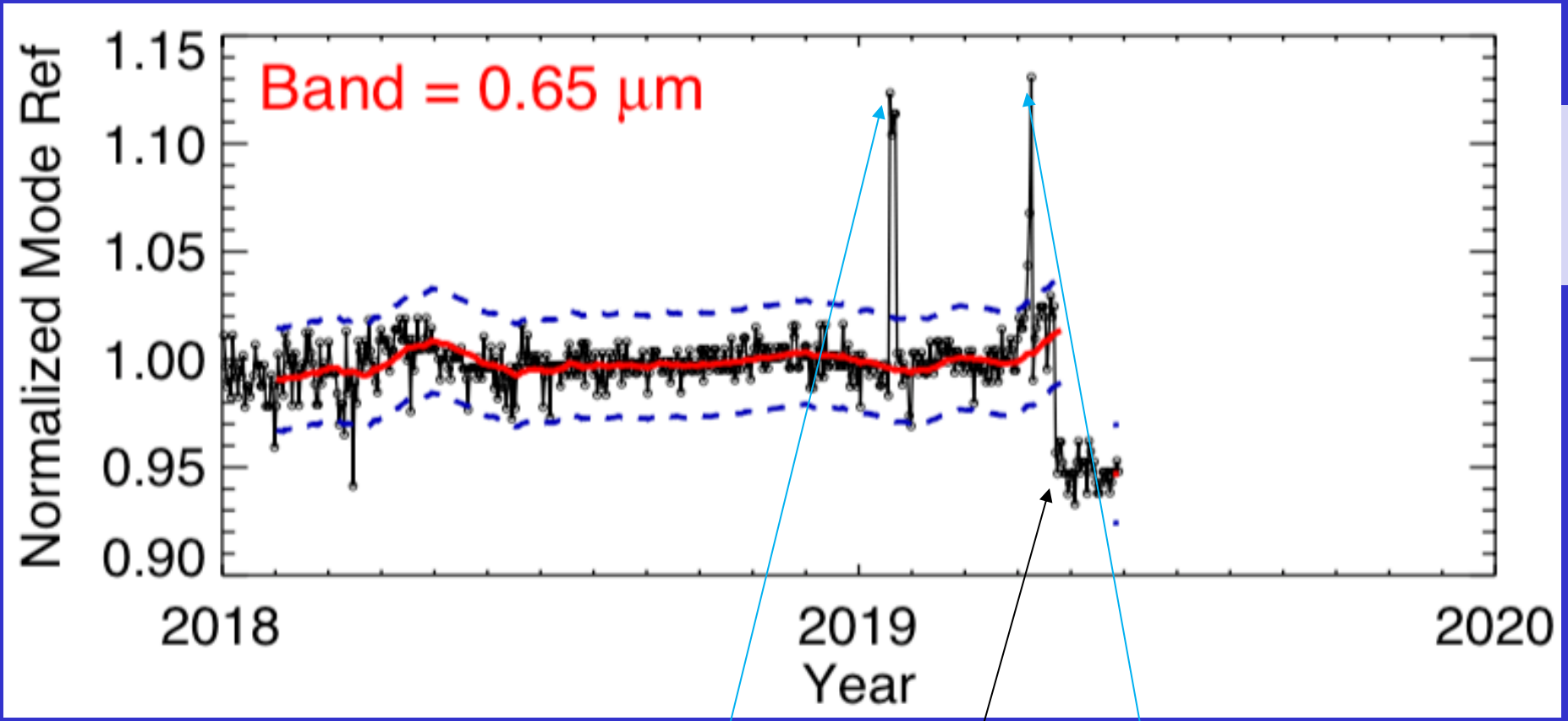




Use 4 times as many GEO images per day to increase sampling

The DCC-IT looks promising to detect daily calibration anomalies

GOES-16 daily DCC-IT gain monitoring



Use the previous 30 days as the baseline for ±3% sigma threshold

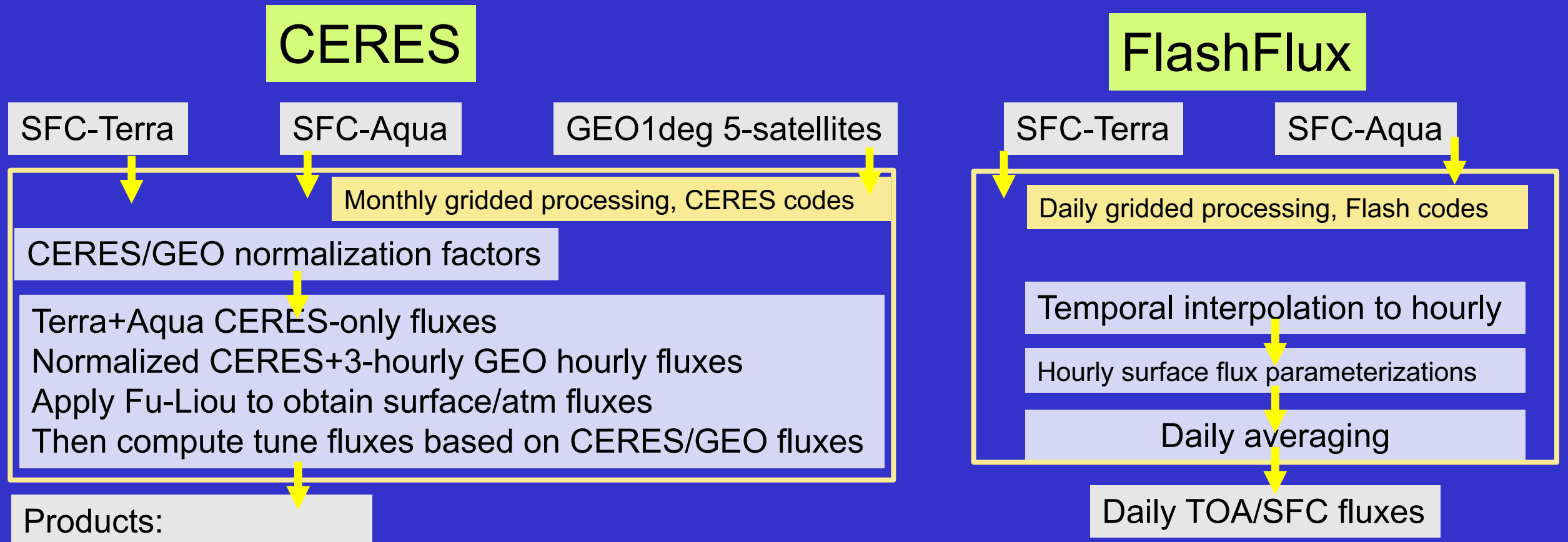
- DCC-IT was able to detect Jan 18-22, 2019, & April 8-9 GOES-16 L1B calibration anomalies
- DCC-IT was also able to predict the April 23, 2019 GOES-16 L1B calibration adjustment
- DCC-IT 3 sigma is ±2.1%

Conclusions

- Edition 5 code re-architecture
  - One overarching framework that facilitates TISA, SARB, and FlashFLUSH products and validation efforts
- TISA code review
  - Based on a TISA library model, where shared subroutines among products remains consistent
  - Ed5 codes will be validated against Ed4 output
- A new GEO daily calibration monitoring system has been developed

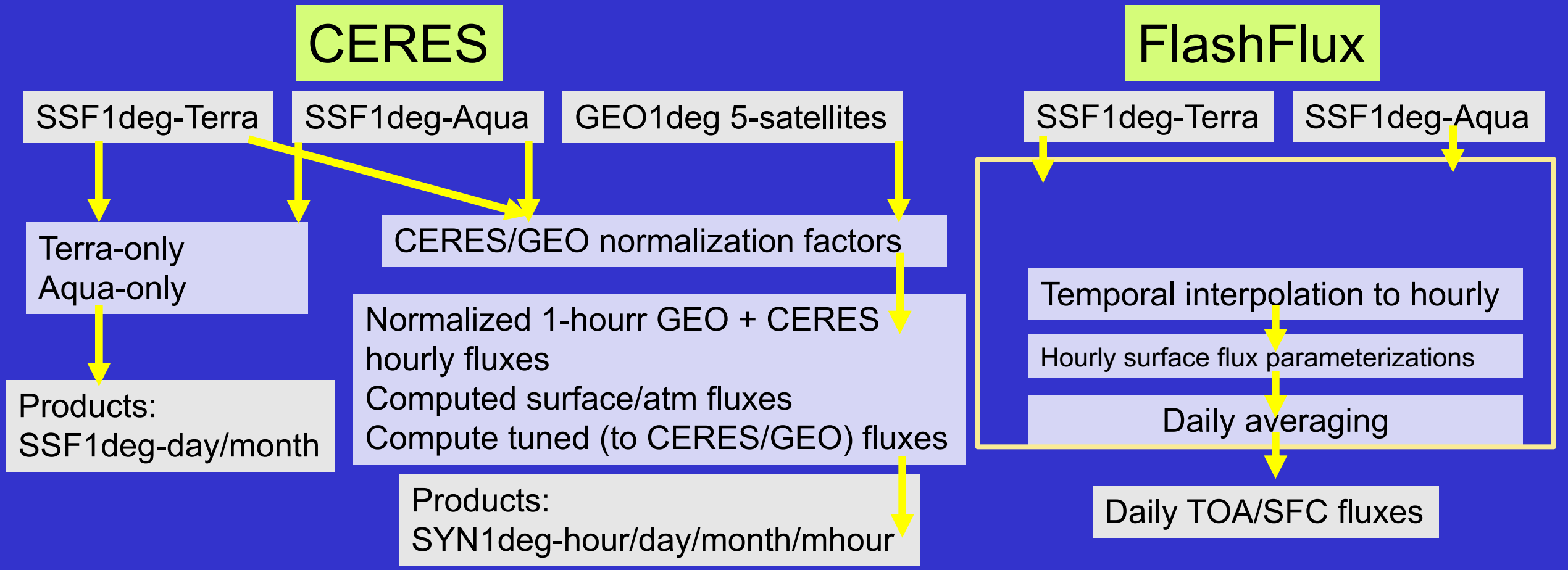
Backup Slides

Ed2 flowchart



- The CERES-only product, which is not being updated, must wait for TISA and SARB
- SARB must wait for TISA for TOA fluxes of the CERES+GEO product to begin improving tuned computed fluxes.

Ed4 flowchart



- The CERES-only product released near real-time
- SARB must wait for TISA for TOA fluxes of the CERES+GEO product to begin improving tuned computed fluxes.

GEO derived broadband fluxes

- The CERES project relies on geostationary (GEO) derived broadband fluxes to infer the regional diurnal cycle in between Terra (10:30AM) and Aqua (1:30PM) CERES measurements.
- The GEO broadband (BB) fluxes are derived from the narrowband (NB) channel imager radiances and associated cloud properties to select the appropriate NB to BB and angular directional models (ADMs) based on scene selection.
- The GEO imager radiances are calibrated against Aqua-MODIS to ensure consistent clouds
- The GEO imager derived broadband fluxes are normalized against the CERES instrument observations to maintain temporal stability in the SYN1deg product
  - The climate quality CERES EBAF-*monthly* TOA fluxes have mostly mitigated all known GEO artifacts
- The GEO imager L1B radiances occasionally show daily anomalies, which can vary up to 10%
  - Need to be mitigated to avoid impacting the GEO BB fluxes in the CERES BB SYN1deg (*hourly*) dataset